This document is guaranteed to be current only to issue date.

Some Mars Global Surveyor documents that relate to flight operations are under revision to accommodate the recently modified mission plan.

Documents that describe the attributes of the MGS spacecraft are generally up-to-date.

542-10

Mars Global Surveyor

PROJECT PLAN

October 5, 1994

Jet Propulsion Laboratory
California Institute of Technology

JPL D-12000

Mars Global Surveyor

PROJECT PLAN

Agreements:

11/4/94

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Project Plan
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PROJECT PLAN

1. INTRODUCTION

1.1 Identification

Title:	Mars Global Surveyor
NASA Program:	Mars Surveyor Program
UPN:	215-00

1.2 Background

The Mars Surveyor Program has been developed as an aggressive but tightly cost-constrained program to explore Mars over the decade from 1997 through 2006. Small orbiters and landers built by industry will be launched at each of the opportunities, 26 months apart, afforded by the relative motion of Earth and Mars in their orbits around the sun. These multiple launches of small spacecraft will provide significant science return in a program that is not reliant on the success of any single component or mission.

The first charge to the Mars Surveyor Program is to capture the science objectives of the Mars Observer mission. This will be accomplished during the 1996 and 1998 opportunities. In November 1996 the Mars Global Surveyor orbiter, launched aboard a Delta II vehicle, will carry duplicates of five MO instruments plus communications equipment to relay data back to earth from follow-on landers.

1.3 Summary

The Mars Global Surveyor mission will provide a spacecraft platform in orbit around Mars, from which the Martian surface, atmosphere and external fields may be examined for one Martian year. The observations address scientific questions, but also provide the understanding needed to help in the planning for future lander missions.

The Mars Global Surveyor mission will use a single spacecraft, procured through a competitive process, that will accommodate the selected payload instruments.

The science investigations will be a sub-set of and utilize, in part, spare instruments previously selected for the Mars Observer mission. The Mars Global Surveyor science complement will consist of:

Mars Orbital Camera (MOC)
Mars Orbital Laser Altimeter (MOLA)
Thermal Emissions Spectrometer (TES)
Magnetometer/Electron Reflectometer (MAG/ER)
Ultrastable Oscillator (USO)

2. MISSION AND PROGRAM OBJECTIVES

The mission objectives are to:

(1) Complete the following science objectives:

(a) characterize surface morphology at high spatial resolution to quantify surface characteristics and geological processes
(b) determine the composition and map the distribution of surface minerals, rocks, and ices; measure the surface thermophysical properties;
(c) determine globally the topography, geodetic figure, and gravitational field;
(d) establish the nature of the magnetic field and map the crustal remnant field;
(e) monitor global weather and thermal structure of the atmosphere;
(f) study surface-atmosphere interaction by monitoring surface features, polar caps, atmospheric dust, and condensate clouds over a seasonal cycle.

(2) Provide at least three (3) years of on-orbit relay communications capability for Mars landers and atmospheric vehicles (e.g. balloons) from both the U.S. and other spacefaring nations; and

(3) Support planning for future Mars missions through data acquisitions with special emphasis on those measurements which could influence landing site selection.

The program objectives are to:

(1) Launch a spacecraft to Mars during the 1996 opportunity

(2) Insert the spacecraft into a near sun synchronous polar orbit at Mars

(3) Carry out a global survey of Mars during one Martian year to collect at least 70% of the science data available for acquisition from the scientific instruments.

3. MANAGEMENT

3.1 Organization and Responsibility

Overall direction of the NASA planetary program is the responsibility of the NASA Associate Administrator for Space Science. He has delegated authority to the Solar System Exploration Division for management of the planetary program.

A Program Manager from the Solar System Exploration Division has been designated who has the technical and fiscal resources management responsibility for the Mars Global Surveyor Program. A Program Scientist has also been designated to serve as the science advisor to the Program Manager, as an ex-officio member of the Project Science Group, and as the headquarters point of contact for scientific matters involving the Mars Global Surveyor Project. Project management is the responsibility of the Jet Propulsion Laboratory (JPL) under Task Order RF 275 of Contract NAS 7-1260.

The Director of JPL has assigned responsibility for all aspects of the JPL Mars Program to the Manager of Mars Exploration Program Office, who in turn has appointed a Project Manager for the Mars Global Surveyor Project.

3.2 Special Boards and Committees

3.2.1Project Level Review Board

A standing Project Review Board has been established for Project Reviews. It is composed of personnel experienced in project and program management from both within and outside JPL.

3.2.2System Level Review Boards

For system level reviews, the standing Project Review Board will be augmented with senior technical personnel with expertise and experience appropriate to the system being reviewed.

3.2.3Subsystem Level Review Boards

Subsystem level review boards will be identified to review each element as necessary. These boards will be composed of technical personnel with expertise and experience appropriate to the element being reviewed.

3.3 Management Support Systems

Specific tools used to support management in planning and controlling the project are:

(1) Integrated Program Master Schedules with at least one controlled milestone per fiscal year

(2) Critical path for identifying those activities with the highest risk of impacting the launch date.

(3) Mission operations development, payload, and spacecraft contractor schedules will be reported to the level of critical path with full cost, schedule and technical reporting made on critical path elements.

(4) Cost management tools to plan and monitor JPL in-house performance and contracted efforts consisting of:

(a) SRM system
(b) Integrated Task Management Report
(c) RSRs, workforce reports, procurement backup detail reports, and services backup detail reports.

These tools will be integrated into monthly reports to the Project Manager providing a timely input as to the financial status of the project.

(5) The project has defined a requirements hierarchy. Changes that impact the requirements defined as Level 1, 2 or 3 will be controlled by the Project Change Control Board.

3.4 Management Approach

The management approach for the Mars Global Surveyor is characterized as follows:

(1) bounded by constraints on the Project

(a) funding availability
(b) schedule
(c) requirements levied by the customer, in this case being NASA Headquarters and the science community

(2) molded by how the work is planned

(3) assured by how the work is controlled

The management approach for the Mars Global Surveyor was reviewed by an independent review team appointed by the Deputy Associate Administrator for the Office of Space Science. In response to the findings of this review group, the Project will:

(1) Reinforce team building and teamwork throughout the project life through training, retreats, and other mechanisms, in particular with the spacecraft vendor.

(2) Rebalance the MOS development effort due to the large credit from MO inheritance and recover additional funds to be used for risk reduction.

(3) Assure that the internal review process gives equal emphasis to cost and schedule performance as to technical performance.

(4) Sustain an effective systems engineering effort throughout the project life.

4. RELATIONSHIP TO OTHER PROGRAMS

4.1 Related Activities and Studies

The Mars Global Surveyor is a member of the Mars Surveyor Program, which consists of orbiters and landers to be launched at every launch opportunity over the next decade.

The 1996 launches of both the Mars Global Surveyor and the Mars Pathfinder provide an excellent opportunity to combine specific functions of both of these projects. Identified thus far as shared functions are the following:

(1) Launch Vehicle engineering
(2) Launch Operations management

Shared functions within the Mission Operations may be possible, such as, navigation, mission control team, and data administration.

4.2 Related Non-NASA Activities and Studies

The Mars Surveyor Program will be structured in a way to allow natural enhancement by international participation, collaboration and coordination. In particular, the Mars Global Surveyor, as well as all other orbiters, will carry a relay link which is compatible with U.S. landers and international landers.

4.3 Internal NASA Agreements

The following are the internal NASA Agreements developed for the Mars Global Surveyor Project:

(1) Project Plan
(2) Program Commitment Agreement
(3) Mission Requirements Request

Additionally, a Memorandum of Understanding will exist between JPL and the Goddard Space Flight Center for the acquisition of two science instruments, the MOLA and the MAG.

4.4 External Agreements

A Memorandum of Understanding is being negotiated between the National Aeronautics and Space Administration and the Centre Nationale d'Etudes Spatiales for the Mars Relay experiment to be part of the payload on the Mars Global Surveyor.

5. TECHNOLOGY SUMMARY

5.1 Project-level Requirements

(1) launch a single spacecraft to Mars during the 1996 opportunity

(2) obtain data from orbit about Mars to fulfill the science objectives of the mission

(3) place in the Project data base at least 70% of the science data available for acquisition during the mission.

(4) complete the development phase of the Project within the total cost specified in Section 9 of this Project Plan

5.2 System(s)

The Mars Global Surveyor Project is partitioned at the interfaces of major elements into systems. These systems are as follows:

5.2.1Mission System

The Mission System consists of the personnel and facilities necessary for the design and conduct of the mission. Mission design, mission analysis and engineering, navigation, mission operations development, execution of the flight mission and archiving of raw telemetry and navigation data are the elements of this system.

5.2.2Science System

The Science System consists of the science instruments and science investigations, including support to the mission system and the archiving of science data.

5.2.3Spacecraft System

A contractor will be selected to design and fabricate the bus, integrate the payload, support integration of the spacecraft with the launch vehicle, and support mission design and mission operations.

The basic mission function of the spacecraft bus is to deliver the science payload into the Mars mapping orbit, provide support to the science payload for a period of one martian year and for the Mars relay operations during the relay operations phase, and achieve a quarantine orbit, if necessary, at the end of the mission. The contract for the spacecraft will specify the functions the spacecraft must perform and the requirements that must be met.

5.3 System Operations Concept

Mission operations will be conducted at JPL using the Advanced Multimission Operations System. JPL will be responsible for mission operations management, design of the uplink/sequencing process and navigation. The spacecraft contractor, at his remote site, will be responsible, under the direction of JPL, for spacecraft performance analysis, spacecraft health maintenance, and support of the uplink and sequencing process. The science operations and data analysis will be conducted on a remote basis at the home institutions of the investigators. Science instrument operating parameters and sequences will be determined at the investigator's facility and transferred to JPL via electronic links. After these uplink commands are checked against mission and spacecraft constraints, they will be merged with other commands for transmission to the spacecraft. Telemetry data will be formatted for transmission in packets, per standards established by the Consultative Committee on Space Data Systems. All data will be returned to a project data base at JPL. Spacecraft data analysis and generation of supplementary data, such as reconstruction of the attitude of the spacecraft, will be performed at JPL. Science investigators will access the data base to transfer data to their facilities for processing and analysis. Following a short period of data validation and verification, the science investigators will transfer planetary science data (for MGS, reduced data sets) to the Planetary Data System for archival. After this data is archived in the PDS, it will be in the public domain, available for anyone who wishes to analyze it.

5.4 System Constraints

The injection energy requirements and physical dimensions of the Mars Global Surveyor vehicle are within the capabilities of the Delta II (7925) launch vehicle.

The spacecraft will operate for approximately one year in cruise to Mars, two years in orbit to achieve the science mission and for three additional years in orbit to perform a data relay function.

The baseline Project will be conducted within a total development cost of $154.5M in real year dollars.

Mars Global Surveyor will comply with all of the requirements for biological protection of Mars and its satellites as set forth in Planetary Protection Provisions for Robotic Extraterrestrial Missions, NHB 8020.12B (the final review draft dated 5/16/94 or the issue when released).

5.5 Ground Systems and Support

The JPL Multimission Operations Systems Office (MOSO), as part of the Telecommunications and Mission Operations Directorate, will provide the Advanced Multimission Operations System hardware, software, operations personnel, and facilities for supporting flight operations. These functions include:

(1) Navigation support, including ephemeris generation
(2) Command translation and transmission to the ground communications facility
(3) Telemetry data processing, analysis and display
(4) Data storage, retrieval, and distribution
(5) Simulation of telemetry and DSN monitor data
(6) Telecommunication system analysis
(7) Sequence planning and generation support
(8) Spacecraft and operations system testing support
(9) Operation of the AMMOS and validation of its performance.

The JPL Office of Tracking and Data Acquisition, as part of the Telecommunications and Mission Operations Directorate, will provide X-band uplink and downlink communications as specified in the Mission Requirements Request (MRR).

The JPL Office of Tracking and Data Acquisition, as part of the Telecommunications and Mission Operations Directorate, will also provide use of the hardware, software, resources for computer operations, and operations personnel of the Network Operations Center (NOC), which in turn provides:

(1) operation of the DSN and validation of its performance
(2) spacecraft telemetry frame synchronization, decoding and error correction of data received from the DSSs;
(3) command message transmission to DSSs;
(4) radiometric tracking data preconditioning
(5) radio science experiment support.
(6) communications links to the remote science facilities, spacecraft contractor site, and Kennedy Space Center (KSC)

5.6 Facilities

Facilities are required for the conduct of: instrument and spacecraft development, assembly and test; instrument and spacecraft environmental test; launch operations; and mission operations. The spacecraft contractor will provide the facilities required for spacecraft development, assembly, instrument integration, and environmental test and spacecraft operations facilities for system test control and flight operations. The spacecraft contractor will also provide facilities for magnetic field background characterization of the instruments and the spacecraft. The instrument suppliers will provide the necessary facilities for development, assembly, and test of the instruments. The home institutions of the appropriate science investigators will supply the mission operations science team and data analysis facilities.

The Telecommunications Development Laboratory (TDL) will be used for characterizing the radiometric performance of the spacecraft radio when interfaced with DSN equipment, as well as for performance testing of the transponder/USO combination. The DSN Development and Test Facility (DTF 93) will be used for DSN compatibility test and verification.

Existing facilities at the Kennedy Space Center (KSC) will be used for prelaunch operations include a Payload Processing Facility, a Hazardous Processing Facility, a spin balancing facility and the Compatibility Test Van to support prelaunch and compatibility testing among the spacecraft, the DSN, and the JPL Mission Operations System.

Launch Complex 17 at the Cape Canaveral Air Force Station (CCAFS) will be used for launch pad operations with the Delta launch vehicle. During both the KSC and CCAFS operations, elements of the NASA Communication Network (NASCOM) will be used.

Facilities used during mission operations for the conduct of the mission include elements of the DSN, elements of the NASCOM, and elements of the AMMOS at JPL, including the mission support area (MSA) facilities to house the Project offices and operations teams.

No requirements for new or modified Government or contractor facilities have been identified and no new facilities are planned.

5.7 Logistics

Provisions for cost effective and efficient logistics support will be included in the requirements, design and operating plans for the three project systems.

Providers of science instruments are responsible for delivering their hardware on schedule to the spacecraft contractor's assembly facility.

The spacecraft contractor will provide for the acquisition of the component parts required for assembly and test of the spacecraft bus, and will be responsible for transporting the spacecraft to the launch site.

The mission system's ground data system will be designed for rapid and low error delivery of data from the DSN stations to and from the remote science and spacecraft operations sites.

5.8 Mission Results Analysis and Reporting

Science analysis, interpretation, documentation and the preparation of reduced and analyzed data record sets from data acquired during the course of the mission will be accomplished by the Science Teams and Investigator groups acquiring the data. A description of the data policy will be contained in the Mars Global Surveyor Science Data Management Plan. The contracts or letters of agreements negotiated with the investigators will specify the investigator's responsibility for data reduction, data analysis, publication of results, and the preparation and the timely documentation of reduced and supplementary data for delivery to a data dissemination repository as specified in the Science Data Management Plan. The mission system manager is responsible for assuring that adequate data security measures are taken to protect project data.

The Project will ensure the timely delivery of raw data to the investigators, as well as preparing raw data for archiving.

6. TASK DESCRIPTIONS

6.1 Implementation Approach

JPL is responsible for Project management, acquisition of the spacecraft and the scientific instruments, development of the mission operations system and flight operations of the spacecraft, for the data processing capabilities and operational support provided by the AMMOS, and for operation of the institutional tracking and data system (the DSN). The Goddard Space Flight Center is responsible for the acquisition of launch services using a Delta launch vehicle, for physical integration of the spacecraft with the launch vehicle and for launch and placement in the proper orbit for injection into the trans-Mars trajectory. The Kennedy Space Center is responsible for providing the launch site and launch site support services.

Project Management, at JPL, will follow a cost driven paradigm and use innovative approaches to project management and control.

The Mission system will be implemented in-house at JPL, using existing institutional mission design and mission operations capabilities, many of which have been inherited from previous missions. While control of flight operations will reside at JPL, spacecraft performance analysis and health maintenance will be conducted remotely from the spacecraft contractor's site. Remotely located workstations will allow science experimenters to remain at their home institutions and interactively participate in mission operations planning, access the Project data base and acquire that data for analysis of its scientific and engineering content and for processed data archive and archival or access by other investigators.

The Science system will be managed by JPL, but the elements of the system will be acquired through contracted efforts, NASA centers or from other Government agencies. The implementation of science investigations will be definitized with the selected principal investigators through a contract, a Letter of Agreement, or a Memorandum of Understanding, depending upon the agency responsible for the investigation.

The spacecraft system will be managed by JPL but procured through a competitive procurement. JPL will provide to the contractor, as Government furnished equipment and support, spacecraft spares from Mars Observer, the Payload Data Subsystem, the Command Detector Unit, the science instruments, and the engineering support for this equipment.

6.2 Project Summary Work Breakdown Structure

The Mars Global Surveyor work breakdown structure defines all work necessary to complete the project, is a product oriented, hierarchical division of deliverable items and relates the elements of work to each other and to the end item. The work breakdown structure is included as Figure 1.

7. PROCUREMENT SUMMARY

The basic procurement approach is directed toward the efficient use of industry to complement available NASA and JPL resources.

All procurements will be competitive unless it can be demonstrated that competition is impractical.

7.1 Science Investigation Procurements

NASA has selected a subset of the Mars Observer science investigations for the Mars Global Surveyor mission, and has formally notified JPL of this decision. These investigations were competitively selected in 1986 through the Mars Observer Announcement of Opportunity.

7.2 Spacecraft System Procurement

The spacecraft is being procured from an industrial contractor. The contract type will be Cost Reimbursable with On-orbit Performance Fee. The fee approach is predicated on JPL's firm belief that no unplanned cost growth will be tolerated. If it appears that the spacecraft contract will overrun, the performance will be descoped to maintain the cost cap and the opportunity to earn the full performance based fee will decrease.

A system contract approach is being utilized for Mars Global Surveyor to:

(1) take advantage of the contractor's depth and flexibility in order to meet the short schedule

(2) minimize cost and risk by using existing contractor designs and capabilities and

(3) to encourage NASA and industry partnering

7.3 Other Procurements

The Delta II Launch Vehicle services will be provided by NASA.

8. SCHEDULES

The Project Master Schedule is displayed as Figure 2. Schedules for the Mission, Payload and Spacecraft system have been developed and will be updated on a monthly basis.

Level 1 Milestones are as follows:

Project Start	February 1994
System Requirements Review	April 1994
Critical Design Review	May 1995
System Test Readiness Review	October 1995
Spacecraft Ship to Launch Site	September 1996
Launch	November 1996

9. RESOURCES

9.1 Funding Requirements (in millions of dollars)

At Project start the funding requirements were:

	FY94	FY95	FY96	FY97	TOTAL
TOTAL NOA	14.5	74.5	56.3	9.1	154.5

9.2 Institutional Requirements

There are no additional institutional requirements.

10. MANAGEMENT REVIEWS

10.1 Program (Agency) Level Reviews

The Program (Agency) Level Reviews are contained in Figure 3. The reporting requirements for each are contained in this figure.

10.1.1 Combined Reviews

In Phases C and D, the Independent Readiness Reviews (IRR) and Independent Annual Reviews (IAR) will be held simultaneously with Project level reviews to the extent possible.

Quarterly Status Reviews will be combined with other major events, occurring in the same quarter, if appropriate.

10.2 Project Level Reviews

The Project Level Reviews are contained in Figure 4. The reporting requirements for each are contained in this figure.

11. CONTROLS

Controlled items are those specified items requiring approval at NASA senior management level before the item can be established or changed. These controlled items are listed below:

NASA Administrator

(1) Program, Project, and mission objectives.

(2) NASA field center assignments, and changes in assignment of major responsibilities to field centers, industry, universities, and other agencies

(3) The number of flight missions and the number of flight spacecraft

(4) The launch vehicle and the launch readiness date.

(5) Total program funding and funding for each fiscal year.

(6) Interagency and international agreements

NASA Associate Administrator for Space Science

(1) Science experiment and instrument selection

(2) Selection of each Principal Investigator, Co-Investigator, Science Team Leader, Science Team Member, and Interdisciplinary Scientist.

(3) Level 1 milestones.

(4) Changes in the procurement strategy

(5) Annual obligation authority available to JPL

12. MISSION ASSURANCE

12.1 General

The MGS spacecraft will be implemented with Class A mission assurance provisions. The MGS science instruments will be implemented with Class B mission assurance provisions. The MGS mission operations system will be implemented with provisions typical of a Class A mission. In order to implement these provisions, the Project will concentrate on maximum satisfaction of the principal intent of these provisions within the cost and schedule driven paradigm. All previously approved waivers, PFRs, NSPARs, ISAs and deviation documentation that apply to inherited elements for MGS use will be reviewed against MGS requirements.

12.2 Reliability

The spacecraft reliability assurance approach will satisfy the requirements of NHB 5300.4 (1A-1). No mission critical single point failures will be allowed without the Project Manager's approval. Design analyses are required and a formal Problem/Failure Reporting system will be implemented. There will be particular design analysis focus on FMECAs.

12.3 Quality Assurance

The spacecraft Quality Assurance (QA) approach will satisfy the requirements of NHB 5300.4 (1B) and NHB 5300.4 (1C). Instrument QA requirements include activities necessary to assure interface requirements compliance.

12.4 Parts

Standard and non-standard parts used on MGS will meet Grade 1 equivalent specifications, either through initial manufacture or additional screening. Non-standard parts will be controlled by NSPAR, when not approved in the parts list review process or previously approved for use on MO. All new parts lists will be reviewed by JPL for reliability and radiation issues and action. All parts lists will be reviewed against the GIDEP Alert database.

12.5 Materials and Processes Control

Spacecraft materials and processes control will utilize the contractor's standards for high-reliability spacecraft projects. Changes to science instrument materials from the MO baseline will be controlled as Class I changes, and an updated materials list will be submitted at the Science Instrument Delivery Review.

12.6 Performance Verification

A verification and test program for the spacecraft, science instruments, and mission operations system will be conducted to verify compliance with requirements for design, performance and interfaces, as well as to demonstrate performance margins, spacecraft compatibility with the Deep Space Network, Mission Operations System and Launch Vehicle, and to qualify the spacecraft and instruments for the mission environments. The science instrument teams will assure that the performance and calibration of the science instruments are sufficient to conduct their investigations.

Verification program planning will be conducted in a top-down fashion from external interface, mission and project requirements down and in a bottoms-up fashion from the component level up. Performance verification implementation will include analysis, inspection, and testing from the component level through the end-to-end mission system that includes all project elements.

Previously verified hardware and software will undergo a reduced component level verification program that is related to the adequacy of prior verification to MGS requirements.

12.7 Contamination Allowance and Control

The spacecraft will be maintained under Class 100,000 contamination control from final assembly to delivery to the launch vehicle (see Paragraph 5.4 System Constraints).

12.8 Software Assurance

Key software assurance requirements include software management plans, software documentation, configuration management, margin management, delivery review and testing. The focal point for planning software assurance will be the applicable software management plan. Software assurance implementation will focus on conformance to the agreed-to software management plan, strict control of the applicable previously-approved baseline and careful attention to the effects of changes to the applicable previously-approved baseline.

12.9 Maintainability

Mars Global Surveyor systems will be designed, where applicable and practical (excludes the existing spares etc.), to ensure maintainability so as to reduce the life cycle costs. Where new software is required, maintainability will be enhanced by applying modern software engineering practices. Software documentation will be understandable, complete and compatible with the software being used.

13. RISK ASSESSMENT

The project will maintain a disciplined approach to risk management through the implementation of a risk management program which identifies cost, schedule and technical risks. This approach utilizes integrated risk assessments to support management decision making, and communicates to NASA management the significance of the assessed risks and the decisions made with respect to them.

The launch period is established by celestial mechanics considerations and must be met in order to minimize launch vehicle energy requirements. To minimize the risk of missing this launch date, sufficient schedule margin has been incorporated into the project schedule, particularly spacecraft fabrication, assembly, test and integration.

Aerobraking is baselined so as to allow for greater mass to be placed in orbit about Mars. To minimize the risk of unintentionally impacting the planet, techniques will be developed and employed to ensure that there is sufficient propellant and control to raise the spacecraft to a stable circular orbit at any time. Analysis of Magellan aerobraking performance data, and data from the in-flight dynamic experiment performed by the Magellan spacecraft will be used to mitigate aerobraking risk for the Mars Global Surveyor.

14. ENVIRONMENTAL IMPACT

The environmental implications and alternatives of the Project are considered equivalent to those of any other project (NASA, DOD, or commercial) launched by expendable launch vehicles from the Eastern Space and Missile Center and not utilizing special nuclear material or radioisotope thermoelectric generators. To meet the requirements of the National Environmental Policy Act, a formal environmental assessment will be prepared using the procedures provided in NASA NHB 8800.11, "Implementing the Provisions of the National Environmental Policy Act."

15. SAFETY

15.1 Industrial Safety

JPL personnel and facilities are continuously monitored in order to assure safe working practices, as well as a safe working environment for JPL personnel and contractors. Electrical safety, Fire and Life safety, Pressure Systems safety and construction safety are the primary issues addressed from both a hazard abatement and remediation standpoint, as well as from a code compliance standpoint.

Formal and informal safety inspections of facilities, operational safety reviews, facility readiness reviews, mishap reports and formal training programs assure Laboratory compliance with CAL/OSHA, NEC, NFPA, UBC Codes as well as specific contractual NASA requirements.

All buildings containing flight hardware are monitored for Industrial Safety concerns including lifting and elevating equipment, fire suppression systems, pressure systems and components, life safety issues, building modifications, access and egress issues, evacuation procedures, emergency response, etc.

15.2 Range Safety

The Air Force Range Safety Group at Patrick Air Force Base requires that all equipment, flight hardware and operations at Cape Canaveral Air Force Station (CCAFS) comply with ERR 127-1 "Eastern Range Regulation -- Range Safety." Furthermore, since the majority of the spacecraft pre-launch servicing is performed at Kennedy Space Center (KSC), compliance with GP-1098 "KSC Ground Operations Safety Plan" is also required. Both of these documents have been imposed on JPL and the spacecraft system contractor and instrument suppliers.

As required by ERR 127-1, a Missile System Pre-launch Safety Package will be prepared which describes the flight article and any potentially hazardous ground support equipment and operations. Hazards involved with the equipment and its use during pre-launch preparation of the flight hardware are identified as well as the methods by which the hazards are eliminated, controlled and verified. Air Force and KSC approval of this document will be obtained prior to shipment of the flight spacecraft and GSE to the launch site.

15.3 System Safety

All hardware and support equipment will be designed and operated in a manner to ensure safety of both personnel and equipment during all phases of fabrication, test and operations. This is accomplished to the maximum degree practical by assuring that the hardware design has the appropriate safety characteristics.

Hazards that cannot be eliminated by design are dealt with by proper procedures, safeguards, operational techniques, training programs and monitoring and alarm systems. In order of descending significance, the following considerations are addressed: (1) personnel safety, (2) flight critical equipment catastrophic damage, and (3) flight critical equipment degradation.

Project safety requirements will be documented in the Project Safety Plan which will define the approach to be used and requirements to be met throughout all Project activities. Requirements for in-house efforts will be defined in accordance with JPL safety policy and JPL Document D-560, JPL Standard for Systems Safety". The Plan will require safety activities commensurate with the potential hazards to either equipment or personnel associated with the Project. It will identify Project organizational requirements responsibilities, and authorities for performing the safety functions.

The spacecraft contractor will have a safety program, which meets the intent of D-11411, Volume 1, System Safety Standards for JPL Contractors, with provisions to ensure that the contractor and JPL safety programs are mutually compatible and interactive. The contractor will generate a definitive Spacecraft System Safety Plan for approval by JPL.

Science instrument safety requirements will be met through the safety plan, safety analysis, and safety support required by the contract or letter agreement for the procurement of the science instrument. This will include agreements to meet all safety requirements established by the Project.

16. SECURITY

The Project's ground system with its distributed architecture is largely supported by the services of the multimission Deep Space Network (DSN), Multimission Operations Systems Office (MOSO), and NASA Communications (NASCOM). Its remote operations facilities, located at universities, government, and private companies facilities are networked to the main facility at JPL. This diversified support requires that data integrity internal to the project be maintained and, furthermore, that no compromise is made to organizations or facilities providing support to the project.

Each organization in the project has its own set of regulations regarding the use of its facility and preservation of data integrity and computer security.

The Mars Global Surveyor Mission Security Plan, Document No. 542-404, sets forth the regulations to be followed across the project to mitigate security breaches.

17. EDUCATION

The Mars Global Surveyor Project will conduct a vigorous educational program designed to be a significant contributor to NASA's educational vision of promoting excellence in America's education system. In doing so, it will help expand America's scientific and technological competence.

18. TECHNOLOGY TRANSFER

The Project has no specific technology transfer objectives.

MARS GLOBAL SURVEYOR
WORK BREAKDOWN STRUCTURE
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		542-2202-	C&DH SUPPORT		
			542-22021	C&DH MONITORING	348
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		533-P2010	PAYLOAD RELIABILITY SUPPORT		521
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		533-3601-	MARS OBSERVER CAMERA		
			533-36010	MOC FACILITY MAINTENANCE	152
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		542-45050	MCT SUPPORT	391
50000	LAUNCH OPERATIONS SYSTEM			
	500	LAUNCH OPERATIONS MANAGMENT		
		50010	LAUNCH SITE MANAGER	

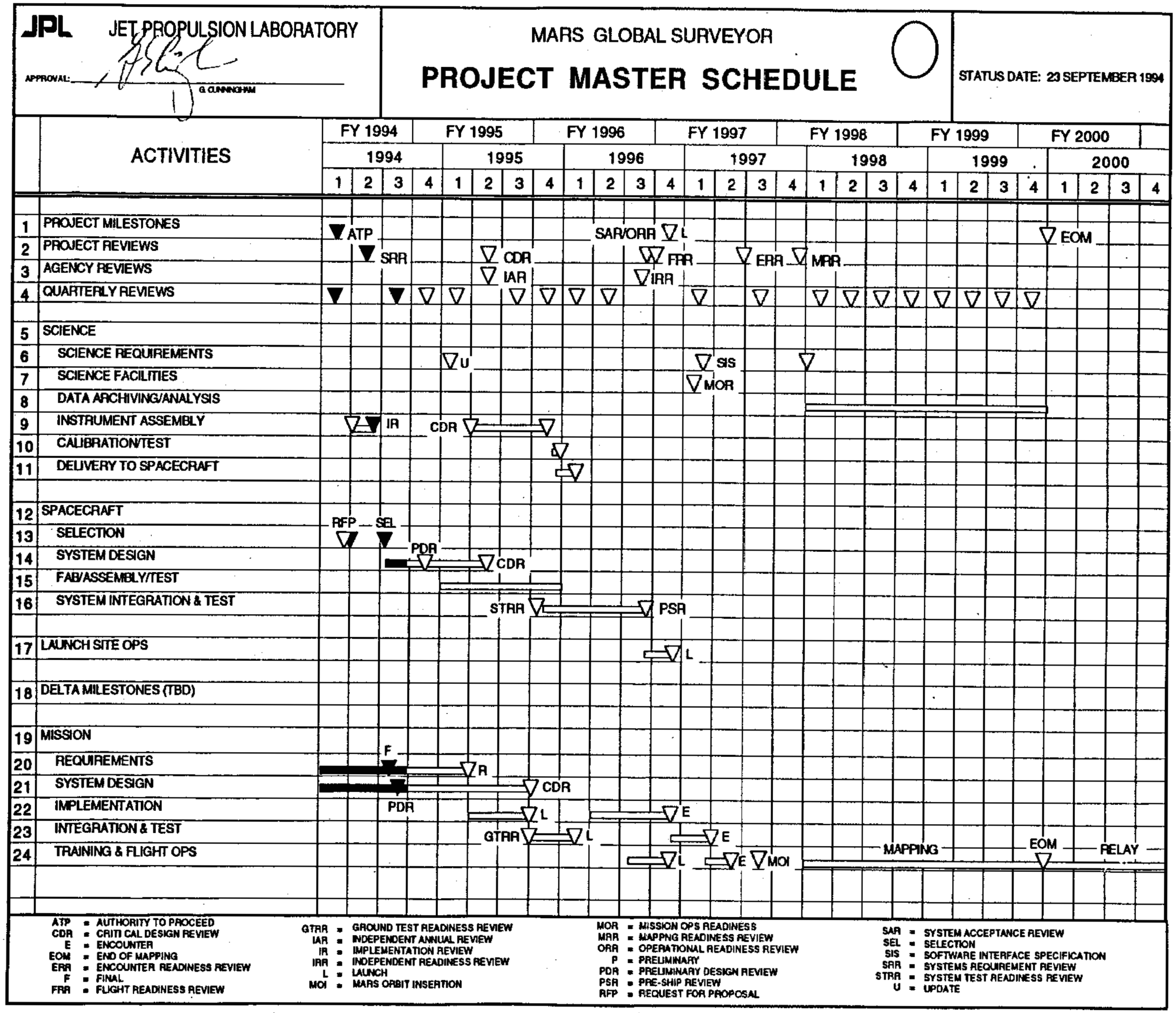
JPL JET PROPULSION LABORATORY
APPROVAL: G. CUNNINGHAM
MARS GLOBAL SURVEYOR
PROJECT MASTER SCHEDULE
STATUS DATE: 23 SEPTEMBER 1994
ACTIVITIES
FY 1994 FY 1995 FY 1996 FY 1997 FY 1998 FY 1999 FY 2000
1994 1995 1996 1997 1998 1999 2000
1 PROJECT MILESTONES
2 PROJECT REVIEWS
3 AGENCY REVIEWS
4 QUARTERLY REVIEWS
5 SCIENCE
6 SCIENCE REQUIREMENTS
7 SCIENCE FACILITIES
8 DATA ARCHIVING/ANALYSIS
9 INSTRUMENT ASSEMBLY
10 CALIBRATION/TEST
11 DELIVERY TO SPACECRAFT
12 SPACECRAFT
13 SELECTION
14 SYSTEM DESIGN
15 FAB/ASSEMBLY/TEST
16 SYSTEM INTEGRATION & TEST
17 LAUNCH SITE OPS
18 DELTA MILESTONES (TBD)
19 MISSION
20 REQUIREMENTS
21 SYSTEM DESIGN
22 IMPLEMENTATION
23 INTEGRATION & TEST
24 TRAINING & FLIGHT OPS
ATP
SAR/ORR
L
EOM
SRR
CDR
FRR
ERR
MRR
IAR
IRR
U
SIS
MOR
IR
CDR
RFP
SEL
PDR
CDR
STRR
PSR
L
F
R
CDR
PDR
L
E
GTRR
L
E
L
E
MOI
MAPPING
EOM
RELAY
ATP = AUTHORITY TO PROCEED
CDR = CRITICAL DESIGN REVIEW
E = ENCOUNTER
EOM = END OF MAPPING
ERR = ENCOUNTER READINESS REVIEW
F = FINAL
FRR = FLIGHT READINESS REVIEW
GTRR = GROUND TEST READINESS REVIEW
IAR = INDEPENDENT ANNUAL REVIEW
IR = IMPLEMENTATION REVIEW
IRR = INDEPENDENT READINESS REVIEW
L = LAUNCH
MOI = MARS ORBIT INSERTION
MOR = MISSION OPS READINESS
MRR = MAPPING READINESS REVIEW
ORR = OPERATIONAL READINESS REVIEW
P = PRELIMINARY
PDR = PRELIMINARY DESIGN REVIEW
PSR = PRE-SHIP REVIEW
RFP = REQUEST FOR PROPOSAL
SAR = SYSTEM ACCEPTANCE REVIEW
SEL = SELECTION
SIS = SOFTWARE INTERFACE SPECIFICATION
SRR = SYSTEMS REQUIREMENT REVIEW
STRR = SYSTEM TEST READINESS REVIEW
U = UPDATE

Figure 2

MARS GLOBAL SURVEYOR
AGENCY REVIEWS

PHASE	REVIEW	PROGRAM/ PROJECT	OBJECTIVE	SCHEDULED DATE
BEGINS AT C	INDEPENDENT ANNUAL REVIEWS (IAR)	PROGRAM	PROVIDES AN INDEPENDENT VERIFICATION THAT PROGRAM/PROJECT COMMITMENTS IN THE PROGRAM COMMITMENT AGREEMENTS ARE BEING MET.	CY95 - 2ND QTR
BEGINS AT C	INDEPENDENT READINESS REVIEW (IRR)	PROGRAM	PROVIDES AN INDEPENDENT ASSESSMENT OF PROGRESS TOWARD LAUNCH.	CY96 - 3RD QTR

Figure 3

MARS GLOBAL SURVEYOR
PROJECT REVIEWS

PHASE	REVIEW	PROGRAM/ PROJECT	OBJECTIVE	SCHEDULED DATE
B	SYSTEMS REQUIREMENTS REVIEW (SRR)	PROJECT	CONFIRMS THAT THE REQUIREMENTS AND THEIR ALLOCATIONS CONTAINED IN THE SYSTEM/SEGMENT SPECIFICATIONS ARE SUFFICIENT TO MEET PROJECT OBJECTIVES.	COMPLETED; 4/94
C	CRITICAL DESIGN REVIEW (CDR)	PROJECT	CONFIRMS THAT THE PROJECTS SYSTEM, SUBSYSTEM, AND COMPONENT DESIGN IS OF SUFFICIENT DETAIL TO ALLOW FOR ORDERLY HARDWARE/SOFTWARE MANUFACTURING, INTEGRATION, AND TESTING AND REPRESENTS ACCEPTABLE RISK.	CY95 - 2ND QTR
D	SYSTEM ACCEPTANCE REVIEW (SAR)/OPERATIONAL READINESS REVIEW (ORR)	PROJECT	DEMONSTRATES THAT THE SYSTEM ELEMENTS CONSTRUCTED FOR USE WILL MEET ALL THE SYSTEM REQUIREMENTS; VERIFIES THAT THE OPERATIONAL SUPPORT ELEMENTS OF THE SYSTEM ARE READY TO SUPPORT SYSTEM OPERATIONS.	CY96 - 3RD QTR
D	FLIGHT READINESS REVIEW (FRR)	PROJECT	VERIFIES THE SYSTEM ELEMENTS CONSTRUCTED FOR USE AND THE EXISTING SUPPORT ELEMENTS ARE READY FOR LAUNCH	CY96 - 4TH QTR

Figure 4